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Storage of SWEET CHERRIES in Controlled Atmospheres

U.S. DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service
Market Quality Research Division

STORAGE OF SWEET CHERRIES IN CONTROLLED ATMOSPHERES

Harold A. Schomer, supervisory plant physiologist, and
Kenneth L. Olsen, plant physiologist
Agricultural Marketing Service
Horticultural Crops Branch
Wenatchee, Washington

SUMMARY

Tests show that sweet cherries held for 25 days in refrigerated controlled atmospheres containing 10-percent carbon dioxide still had fair quality after 2 days at 70°. The controlled atmosphere retarded decay and acid loss in the fruit and preserved its fresh appearance. The benefits were comparable to those obtained by the use of sealed polyethylene liners.

BACKGROUND

Sweet cherries are very perishable fruits. After harvest they cannot be held long in storage without visible deterioration. In the attempt to market the cherries as they are harvested and packed, a market glut often occurs near the peak of the season.

The use of sealed polyethylene liners permits an extension of the holding period in cold storage. Occasionally, cherries packed in polyethylene liners are held at 31° F. for 2 to 3 weeks. The polyethylene liners perform two important functions: (1) Provide high humidity within the liners which retards moisture loss from the cherries and helps preserve the green color of the stems, and (2), allows the accumulation of carbon dioxide from respiration which helps maintain quality. Beneficial effects of carbon dioxide for cherries have been reported by several investigators[1], [2], [3]. The use of dry ice to add carbon dioxide (CO_2) to the atmosphere in carloads of cherries was standard practice in the Northwest until the use of polyethylene liners reduced the need for added CO_2 in the car atmosphere. A 1.5 mil sealed polyethylene liner maintains CO_2 at approximately 6 to 9 percent at 31° F. At this level, CO_2 helps preserve the fresh, bright appearance of the cherries.

The increase in numbers of controlled-atmosphere rooms for apple storage in the Northwest would allow the use of these facilities for cherries and other soft fruits if any advantage over regular storage would accrue. The CA storage facilities are available during a part of the year which would not conflict with apple storage.

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[1] Brooks, Charles, Bratley, C. O., and McColloch, L. P. Transit and storage diseases of fruits and vegetables as affected by initial carbon dioxide treatments. U.S. Dept. Agr. Tech. Bul. 519, 24 pp., illus. 1936. (Out of print; may be consulted in major libraries.)

[2] Gerhardt, Fisk and Ryall, Lloyd. The storage of sweet cherries as influenced by carbon dioxide and volatile fungicides. U.S. Dept. Agr. Tech. Bul. 631, 20 pp., illus. 1939. (Out of print; may be consulted in major libraries.)

[3] Gerhardt, Fisk, Schomer, Harold A., and Wright, T. R. Sealed film lug liners for packing Bing cherries. U.S. Agr. Mktg. Serv. AMS-121, 8 pp., illus. 1956.

EXPERIMENTAL METHODS

Lambert cherries of light mahogany color were selected from the sorting table of a Washington State packer. A kilogram (about 2.2 pounds) of fruit was placed into each of eight 1.5-mil polyethylene bags which were perforated with twenty 1/4-inch holes. Two of the bags were placed into each of four 5-gallon glass jars at 31°F. The jars were sealed with airtight lids with tubes for introduction and escape of air. Premixed air was passed into the jars at a rate of about 3 liters per hour which was equivalent to about one air change every 6 hours.

The premixed air in pressure cylinders was used for continuous aeration of the cherries in the jars. The four air mixtures were:

1. Three-percent oxygen, 97-percent nitrogen.
2. Three-percent oxygen, 10-percent carbon dioxide, 87-percent nitrogen.
3. Ten-percent carbon dioxide in air.
4. Air.

One bag of cherries was removed from each jar at 25- and 50-day intervals. The fruit was examined immediately after it was removed from storage and again after 2 days in air at 70°F. The cherries were graded into 3 groups based on appearance:

1. Fresh, bright.
2. Slightly dull, aged.
3. Advanced senescence, unattractive.

The stems were rated from 1 to 5 based on the area of brown discoloration.

1. None, stems green.
2. Trace to 25 percent.
3. Twenty-five to 50 percent.
4. Fifty to 75 percent.
5. More than 75 percent.

Decayed fruits were weighed and discarded at each examination. Soluble solids, pH, and total acidity were determined on composite samples from each lot after 2 days at 70°.

RESULTS

25 days storage at 31° F.--Ten-percent carbon dioxide in the atmosphere was beneficial to the cherries. The effect appeared slight at the time of removal from 31°, but after 2 days at 70°, it was more apparent (table 1). Aging, as evidenced by a dull finish on the fruits, increased significantly during the 2 days at 70° in the lots with no carbon dioxide, and although decay increased in all lots, the increase was greater in those without carbon dioxide. The percentage of decaying cherries was less than one half as much in the two lots from the atmospheres with 10-percent carbon dioxide as in the comparable lots without carbon dioxide.

The acid declined more rapidly in cherries from the atmospheres with no carbon dioxide than from those with carbon dioxide, and the pH values varied with the acid level.

Table 1.--Condition of Lambert cherries after storage at 31° F. for 25 days and 50 days in various atmospheres and for 2 additional days at 70° F. in air

Length of storage at 31° F. and storage atmosphere			Percentage of fruit								Chemical analysis after storage and holding		
			Appearance[1] upon removal from storage				Appearance [1] after holding 2 days at 70° F.						
Oxygen (%)	Carbon dioxide (%)	Nitrogen (N) or Air (A)(%)	1	2	3	4	1	2	3	4[2]	Total soluble solids (%)	pH	Total acid (Malic) (%)
25 days:													
3	10.0	87 N	95.1	4.2	0	0.7	94.7	1.2	0	3.6	19.6	3.89	.339
3	0	97 N	91.9	8.1	0	0	84.3	5.7	0	8.5	20.4	3.95	.312
-	10	90 A	96.7	3.3	0	0	94.0	1.4	0	4.3	19.6	3.90	.348
-	-	100 A	94.5	3.0	0	2.5	83.2	5.0	0	11.8	18.7	3.97	.311
50 days:													
3	10	87 N	93.4	2.2	0	4.3	70.7	1.8	0	26.3	19.7	3.91	.313
3	0	97 N	67.3	4.4	0	28.2	27.8	9.8	0	60.4	19.1	4.02	.230
-	10	90 A	98.4	0.8	0	0.8	76.2	5.1	0	17.4	19.4	3.97	.308
-	-	100 A	74.7	6.6	0.7	18.1	39.8	30.0	0	28.6	18.7	3.95	.271

[1] 1 - Fresh, bright appearance.
2 - Slightly dull, aged.
3 - Severely aged, unattractive.
4 - Decayed.

[2] Cumulative. Includes decay found upon removal from storage.

Cherries from all the lots were judged by several tasters to have fair dessert quality (table 2). Those from storage in air had the typical varietal flavor although some staleness was detected. Fruits from atmospheres with 10-percent carbon dioxide had fair dessert quality, and the higher acidity could be detected by taste. Cherries from 3-percent oxygen and 97-percent nitrogen were bland, and were judged poorest of the lots.

None of the atmospheres used controlled stem browning (table 3). All the stems showed some browning at each examination, and most of them were in the severe category in which more than 75 percent of each stem was discolored. Fewer stems became detached after 2 days' holding in the CO_2 lots than in the other lots. This may have been a function of ripening.

50 days storage at 31°F. --In general, the differences between lots that were apparent upon removal from 31° after 25 days were intensified in the lots removed after 50 days. The cherries from atmospheres with no CO_2 had aged much more and had much more decay than those from the 10-percent CO_2 atmospheres. Both aging and decay increased greatly in 2 days at 70° (table 1).

Flavor had declined, but was fair in the lot held in air plus 10-percent carbon dioxide. Some fruits from the other atmospheres had slightly objectionable flavors.

Although an atmosphere containing 10-percent carbon dioxide maintained good appearance and retarded decay development, its employment for a period of 50 days has little commercial value because of the rapid decline of the fruit upon removal from cold storage. After 2 days at 70°, the cherries had aged appreciably in appearance, and serious decay had developed.

CONCLUSIONS

A controlled atmosphere with 10-percent carbon dioxide preserved the fresh appearance and retarded decay and acid loss of sweet cherries in storage at 31°. These benefits are comparable to those obtained previously by the use of sealed polyethylene liners in which the CO_2 level averaged about 6.5 percent and the oxygen about 9 percent. The cherry marketing period was extended by about 3 weeks with the use of the liners.[4] The sealed liners have the advantages of retaining stem turgidity and protecting the cherries during transit.

Table 2.--Flavor evaluations of Lambert cherries after storage for 25 days and 50 days at 31° F. in various atmospheres and for 2 additional days at 70° F.

Oxygen	Carbon dioxide	Nitrogen (N) on Air (A)	Description of flavor	
			25 days	50 days
Percent	Percent	Percent		
3	10	87 (N)	Fair-slight acid.	Slight off-flavor (in most fruits).
3	0	97 (N)	Fair-bland.	Fair, bland. Some slightly off-flavor.
-	10	90 (A)	Fair-slight acid.	Fair flavor. Best of lots.
-	-	100 (A)	Fair-ripe, varietal flavor.	Fair flavor. Tasted like old fruit.

[4] Gerhardt, Fisk, Harold A. Schomer, and T. R. Wright. Film Lug Liners Lengthen Market Life of Sweet Cherries. U.S. Agr. Mktg. Serv. AMS-177, 2 pp., illus. 1957.

Table 3.--Condition of stems after storage of Lambert cherries at 31° F. in various atmospheres for 25 days and 50 days, and for 2 additional days at 70° F. in air

Length of storage at 31° F. and storage atmosphere			Percentage of stems									
			Appearance[1] upon removal from storage					Appearance[1] after holding 2 days at 70° F.				
Oxygen (%)	Carbon Dioxide (%)	Nitrogen (N) or Air (A)	1	2	3	4	5	1[2]	2	3	4	5
25 days:												
3	10	87 (N)	4.0	2.6	13.1	15.9	64.3	7.2	3.0	0	8.0	81.8
3	0	97 (N)	2.1	3.1	2.7	14.3	77.7	13.9	0.6	2.6	6.1	76.8
-	10	90 (A)	2.2	0.8	7.7	18.2	70.9	4.2	0	0	7.8	88.0
-	-	100 (A)	1.7	4.8	1.9	16.7	74.8	6.9	0	4.9	8.2	80.0
50 days:												
3	10	87 (N)	7.3	3.4	4.1	12.3	72.8	21.2	0	0.7	6.0	72.1
3	0	97 (N)	8.3	2.9	3.3	8.2	77.3	60.9	0	3.3	2.9	32.9
-	10	90 (A)	1.4	6.4	6.7	12.6	72.8	22.4	2.9	2.1	7.3	65.2
-	-	100 (A)	4.5	1.5	2.7	2.0	89.2	43.1	0	0	6.0	50.9

[1] Stems detached and extent of brown discoloration.
1. Detached (generally desiccated, brown and would also be classed under 5).
2. Trace to 25%.
3. 25 to 50%.
4. 50 to 75%.
5. Over 75%.

[2] Cumulative. Includes detached stems found upon removal from storage.

The cherries from the 10-percent CO_2 atmospheres were still in fair condition after 25 days of cold storage and an additional 2 days at 70°.

Although the cherries were still attractive after 50 days in a cold-storage atmosphere with 10-percent CO_2, they declined rapidly during 2 days at 70°. Aging and excessive decay after removal from storage would discourage such a long storage period. The beneficial effect of the modified atmosphere on Lambert cherries appeared to be due to the carbon dioxide present. A low oxygen level (3 percent) had no beneficial effect on their storage life.

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